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L. O. HOWARD, Entomologist and Chief of Bureau.

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## PAPERS ON CEREAL AND FORAGE INSECTS.

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# THE CLOVER-ROOT CURCULIO.

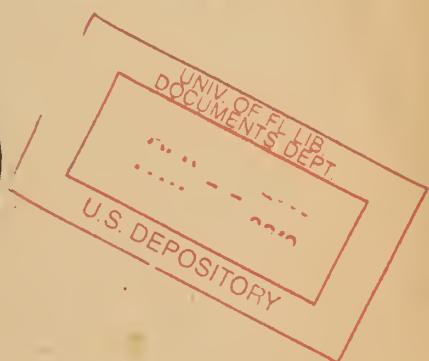
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## PAPERS ON CEREAL AND FORAGE INSECTS.

### THE CLOVER-ROOT CURCULIO.

(*Sitones hispidulus* Fab.)

By V. L. WILDERMUTH,  
*Agent and Expert.*

#### INTRODUCTION.

The genus *Sitones* includes a large number of species, many of which are known to be more or less injurious to leguminous crops. *Sitones puncticollis* Steph. and *S. lineatus* L., frequently called "pea weevils," have been especially destructive at times to peas, beans, and clover in England as well as on the Continent. In the years 1880 to 1882 and 1883 the crop of peas and beans was practically ruined in parts of England. Miss Ormerod (1883, 1884, 1893)<sup>a</sup> stated that the larvae were sometimes known as "white maggots" and that in England they obtain their living from the roots of the plants attacked, while the adults feed on the leaves.

In this country only, the flavescent clover curculio (*S. flarescens* Marsh.) has so far proved the most destructive relative of *S. hispidulus*. *Sitones flarescens* depredates on red and white clover, more particularly the latter, and perhaps does a large amount of obscure damage, being widely distributed over most of the United States (Webster, 1886).

While *S. hispidulus* has never been so abundant in this country as totally to destroy a clover crop, yet there is no doubt that injuries that have before been either unnoticed or else laid at the door of some other clover pests, as *S. puncticollis*, *S. lineatus*, or *Phytonomus punctatus* Fab., or even the clover root-borer (*Hylastinus obscurus* Marsh.), by the ordinary observer, were partly the work of the adults and larvae of this beetle.

From the history of other species of insects that have been imported into this country, and from the fact that late in November, 1909, at two localities, viz. Corning, N. Y., and Marion, Pa., the adults were

<sup>a</sup> See Bibliography, p. 38.

found to have practically eaten up the foliage of clover plants, there is reason to believe that this one may become destructive to the clover crop in future years.

Up to the year 1909 nothing was known regarding the habits of this species in America. Adults were found by Mr. J. A. Hyslop, of this Bureau, early in April, but as Mr. Hyslop was almost immediately thereafter detailed to investigations on the Pacific coast, the writer continued during the remainder of the year the life history study begun by him and succeeded in following out the complete life cycle. The writer is greatly indebted to Prof. F. M. Webster, in charge of cereal and forage insect investigations in the Bureau of Entomology, for his kind direction of the work and for his assistance in the preparation of the manuscript.

#### HISTORY OF THE CLOVER-ROOT CURCULIO IN FOREIGN COUNTRIES.

The clover-root curculio appears to be a native of Europe, originally described by Fabricius (1776) as *Curculio hispidula* and reported by him as inhabiting aquatic plants in the neighborhood of "Kilia." This description seems to have been drawn up prior to 1776. Later Germar (1824) placed it in the genus *Sitones* and reported it among others of this genus as occurring in meadows, along roadsides, and under stones.

In 1831 Stephens stated that the species occurred in abundance on sandy heaths and moist meadows in some half dozen different places in England.

Schoenherr (1834) reported it as being found in northern and temperate Europe. He also described a species found in "Tauria" as *S. hamorrhoidalis*, which was later, in 1864, determined by Allard, in his "Classification of the Genus *Sitones*," as *S. hispidulus* of Germar. At this time Allard stated that *S. hispidulus* was very common all over Europe, as he had received specimens sent by Motschulsky from Holland, Hungary, Caucasia, Poland, central Russia, and eastern Siberia. From this and from Stephens's British report it will be seen that it was even at that time widely distributed throughout Europe, England, and parts of Siberia. This insect has not attracted so much attention as an economic species in Europe as have others of this genus, especially *S. lineatus* and *S. puncticollis*, but Brischke (1876) made some interesting observations on its destructiveness to clover in the vicinity of Dirschau, western Prussia. He found a clover field there of one year's standing overrun by insects. The leaves were badly eaten and the roots brown and dried up. Upon digging up the earth, he found, among the various larvae and pupæ, several larvae and a pupa of a Curculionid which afterwards proved to be those of *Sitones hispidulus*. The larvae were found to feed on

clover roots and the pupæ were concealed in small earthen cells in the ground, the latter requiring only a short time for development, when the adults began their depredations on the remaining clover leaves. It will thus be noted that its record would seem to show that it may become destructive in America.

#### HISTORY OF ITS OCCURRENCE IN AMERICA.

Although it has, since the middle of the last century, been widely distributed over Europe and long before that time was very common in England and parts of Europe, yet it was evidently not introduced into America until much later. The first specimen was collected by Le Conte at Long Branch, N. J., in the year 1876, about the roots of grass growing on sand dunes (Hamilton, 1894). During subsequent years its appearance was also noted and collections made at various places in New Jersey, and in 1886 Mr. E. A. Schwarz found it at Piney Point, Md., while three years later it made its appearance in large numbers in the city of Washington, D. C., being found there on both red and white clover on the White House lot by Mr. Henry Ulke (Schwarz, 1889).

Dr. F. H. Chittenden, of this Bureau, found the species very abundant in Washington, D. C., in 1891, and in the spring of 1896 he found the beetles on clover, many of them in copula, on the Department of Agriculture grounds, but after that time he was able to find them only in limited numbers. Collections made since the early observations of Mr. Schwarz and others show the species to be gradually moving westward. In 1894 specimens were collected by the late Dr. John Hamilton at Pittsburg, Pa. (Hamilton, 1894). In 1906 Mr. W. J. Phillips collected one specimen with wheat sweepings at Richmond, Ind., and in the spring of 1908 the writer found both the larva and adult very plentiful at Groveport, near Columbus, Ohio. A specimen was also secured at Newton-Hamilton, Pa., during the past summer, and later in the season a few specimens were collected at Watertown and Clyde, N. Y., and at Vicksburg, Pa.; while at Corning, N. Y., and at Marion, Pa., the species were found in numbers large enough to be a decided detriment to the clover crop. As many as two dozen adult beetles were found at the base of a single plant at Corning, N. Y., and practically all the clover plants in a mixed clover and timothy meadow had at least one-half to two-thirds of the foliage eaten away. At Marion, Pa., the beetles were about as numerous as at Corning, N. Y., and in a 16-acre clover field from two to six beetles were found at the base of every plant, while the damage done was readily noticeable. The damage, of course, would be more apparent at this time of the year, for the cold weather had already checked the growth of the clover plants and enabled the

beetles to make a considerable showing. Specimens were collected at Old Orchard Beach, Me., between 3 and 4 p. m., September 11, 1909, by Mr. C. A. Davis. At this time the beetles were crawling over the sand along the wave line; the tide was rising and the wind was light and offshore. During the summer of 1909, also, adults were found in an alfalfa field, near Pullman, Wash., by Mr. J. A. Hyslop.

#### SEASONAL HISTORY.

This insect hibernates in the adult form, hiding itself no doubt under rubbish and leaves close to the ground. During the last week of November, 1909, adult males and females were found at Watertown and Corning, N. Y., apparently hibernating. They were lying on the ground under and among the dead leaves and stems of the clover plant. Hibernating individuals begin to die off about the latter part of May or first of June. Miss Ormerod, in her report for 1882, quotes Mr. Cluttenbuck as saying that he found adult *Sitones puncticollis* and *S. lineatus* hibernating in barley, oats, and wheat straw. He says, "We traced the sometimes total loss of the crop of *Trifolium* to this source, inasmuch as we found the insect in the top joint of the stubble, among which we usually drilled the crimson clover (*Trifolium incarnatum*) without plowing." Since the work and habits of *Sitones hispidulus* are so very similar to those of *S. lineatus*, it seems probable that it may hibernate in similar places.

The adults come forth with the first warm days of early spring, and the female very soon begins oviposition. Adults were observed abroad in large numbers by Mr. Hyslop in a small clover field near Grant road, District of Columbia, on the 1st of April, 1909, and when collected in vials they immediately deposited eggs. On May 4 almost fully developed larvae were found by the writer on clover roots at Grant road. Eggs for these must have been deposited during the latter part of March.

The female deposits promiscuously a large number of whitish eggs on the leaves and ground, or even on the side of the cage when confined. In the field eggs were found adhering to the lower leaves of both red clover and alfalfa. Within less than a day these eggs change in color to a shining black. It is very probable, however, that in the natural state the eggs are usually deposited at or near the surface of the ground. The egg period is 13 days in duration. The larvae immediately after hatching go down into the ground. Great trouble was experienced in getting eggs to hatch in rearing cages, and it seems from this that there may possibly be some other as yet unknown condition entering into egg deposition in the field.

The adult beetle endeavors to escape injury or capture by feigning death. If a clover plant upon which this beetle is resting be touched, the beetle drops to the ground and lies there an inactive and almost invisible object. It is only when in motion that one is able to see it readily, since its color harmonizes so well with its surroundings.

The larval period varies from seventeen to twenty-one days, the latter being apparently nearer the normal.

The pupal stage is passed in an earthen cell, which is oval in outline, about three-sixteenths of an inch (5 mm.) long, and half as large in diameter. The time required for the pupal stage is from eight to ten days, easily determined independently of the other two stages by collecting nearly mature larvæ in the field and rearing them to adults.

The larval period was determined by getting the combined length of the egg, larval, and pupal periods and subtracting from these the number of days required for the egg and pupal stages. This method was followed because of the difficulty experienced in getting the newly hatched larvæ to live after being transferred from the vial in which the eggs were hatched to a clover plant on which they could feed, and also because of the fact that the more fully developed larvæ, when disturbed to any extent, nearly always died. Thus, to avoid this, a record was kept of the day of egg deposition in a certain cage and then the beetles were removed and the cage left undisturbed but watched carefully until adults appeared. The time required for this was from thirty-eight to forty-three days, thus making from seventeen to twenty-one days for the larval stage.

Miss Ormerod (1882) has found that in England *Sitones lineatus* and *S. puncticollis*, two closely allied species, have a fall brood. Mr. R. W. Christy, corresponding with Miss Ormerod, stated that as late as October 21 he was unable to find larvæ of *S. puncticollis*, but that during the month of November they were in abundance; while Prof. F. M. Webster, in Indiana (Webster, 1886), has made the same observation in regard to *S. flavescens*. Thus it seemed probable that a fall brood might also occur in *S. hispidulus*, but subsequent observation proves that in the neighborhood of Washington this is not the case.

On September 23 the writer made a thorough but unsuccessful search in a field of clover near Grant road, District of Columbia, for the larvæ of this insect. Adults were found in abundance around the clover crowns, but when placed in confinement these failed to deposit eggs. However, a number of females collected October 7 deposited a dozen or more eggs during the following night. From this time on collections were made every ten days and on each occasion, when placed in vials and left overnight, the females depos-

ited eggs. Of the several hundred eggs collected by this method, however, only two or three hatched. On November 4 the writer, while searching on the grounds of the Washington Monument, at Washington, D. C., found an egg evidently belonging to this species, which, however, failed to hatch. Since the investigation of clover roots at various intervals during October and November failed to reveal any larvae, it seems certain that the second or fall brood is wanting in this locality. These observations fail to explain the reason for the deposition of eggs in vials. However, during the last week in November, while the writer was on an inspection trip through New York and Pennsylvania, an opportunity was afforded him for collecting a large number of beetles, all of which were apparently in the hibernating stage. These, when taken to a warm room, deposited eggs almost immediately. The facility with which

the eggs were deposited in vials may then be accounted for by the fact that these females were just ready to deposit eggs and only awaiting a warm spring day to carry out this work; therefore, on being taken into a warm room the proper degree of temperature was afforded and egg deposition immediately followed.



FIG. 15.—The clover-root curculio (*Sitones hispidulus*): Adult. Greatly enlarged. (Original.)

The adult (fig. 15) is a small, black, hard-bodied beetle, from 3 to 5 mm. in length and from 1.25 to 2 mm. in breadth. It has a short head and a general, deeply punctured appearance on the surface of the head, thorax, and elytra. It was described by Fabricius (Paykull, 1800) as follows:

#### [Translation.]

Head black with fuscous scales. Beak short, concave. Antenna slightly longer than the head. Base rufous. Apex ashy. Eyes large, deep-set. Thorax longer than broad, convex, almost cylindrical, black. Below obscure, ashy scales; above deeply punctured fuscous scales. Ashy scales in the parallel longitudinal lines. Middle one shortest. Scutellum less ashy. Elytra black. Scales densely fuscous and less ashy. Not as wide as thorax but twice as long, convex, punctate-striate, with series of erect, rigid white hairs between the striations. Wings white, hyaline. Breast and abdomen black, with fuscous-rufous scales. Feet rufous. Femora fuscous-ashy, unarmed. As broad as *Curculio hirsutus* but not quite so long.

## THE EGG.

The egg (fig. 16), as observed by Mr. J. A. Hyslop, is very slightly ellipsoidal, almost spherical, and slightly granular, measuring 0.36 mm. in diameter; white when first deposited (fig. 16, *a*), but turning jet-black after twenty-four hours (fig. 16, *b*.)

## THE LARVA.

The newly hatched larva is 0.68 mm. in length by 0.18 mm. in breadth and white. The head is light chocolate, the posterior emarginate portion very light, and the sides darker. The head is very prominent, and cordate, 0.16 mm. in length by 0.19 mm. in breadth, the posterior portion deeply emarginate. The abdomen bears black hairs averaging 0.17 mm. in length.

The full-grown larva (fig. 17) is 5 mm. in length and 1.3 mm. in breadth. It is white, with a tinge of yellow. The head is light chocolate, 1 mm. in length by 0.85 mm.

in breadth. When found in a natural condition the fresh specimen has a purplish tinge, apparently due to the contents of the alimentary canal.

## THE PUPA.

The pupa (fig. 18) is 4 mm. in length, almost white, with a slight tinge of yellow on the dorsal abdominal area. Each segment of the abdomen bears a row of dark hairs and posteriorly at each side of the terminal segment are two very prominent, dark spines, with a secondary spine on the out-

side of each. On the fourth day after pupation the eyes turn reddish brown and on the ninth day the mandibles become the same color.

FIG. 17.—The clover-root curculio: Larva. Greatly enlarged. (Original.)

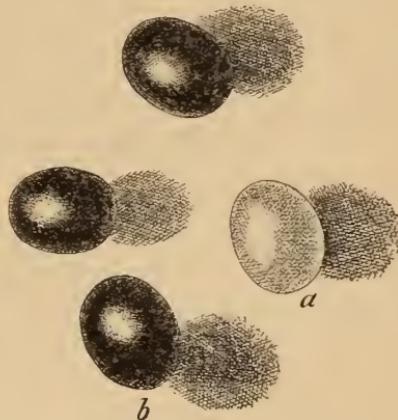


FIG. 16.—The clover-root curculio: *a*, Egg, immediately after oviposition; *b*, egg, one day after oviposition. Greatly enlarged. (Original.)



FIG. 18.—The clover-root curculio: Pupa. Greatly enlarged. (Original.)

## FEEDING HABITS.

The larvæ of this beetle feed on the roots of all the plants mentioned as food plants. The smaller, more tender, or fibrous roots are eaten by the younger larvæ, which, as they become more mature, attack the larger roots. Large cavities are eaten along the main roots, and often these are in the form of a groove containing the feeding larva (fig. 19, *a*). An examination of clover roots, made on September 23, showed clearly the after effects of the work of the larvæ. The roots were eaten at various places, some of them appearing as though the whole surface had been eaten off, the roots being scabby

and brown, the damage having evidently been done during late spring or early in the summer.

The adults feed on the leaves, eating out irregular patches from the margin of the leaf. (Fig. 19, *b*.) They are not as hearty eaters as some of the allied species of beetles that live on clover, and hence their work is not so noticeable, except when the beetles have developed in excessively large numbers, as was the case at Corning, N. Y.

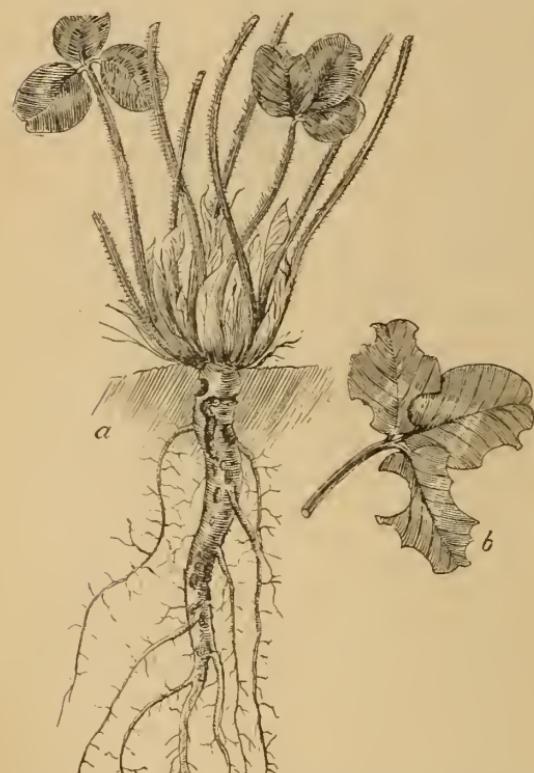


FIG. 19.—The clover-root curculio: *a*, Red clover root showing effects of attack by larvæ; *b*, red clover leaf showing work of adult beetles. About natural size. (Original.)

added. The species *hispidulus*, when first observed in this country by Doctor Le Conte, was reported by him as present around the roots of grasses growing on sand dunes. Stephens in 1831 reported it in England as being abundant on sandy heaths, which were no doubt grown up with grass.

The writer in the spring of 1908 found the larvæ in large numbers in a blue-grass pasture. These were to all appearances feeding

## FOOD PLANTS.

While the genus *Trifolium* seems to provide the natural food plants of this insect, there are reasons for believing that others may in future be

partly on blue-grass roots, as the only clover present was *T. repens*, and this was rather scattering in the field. From this it would seem that some of the grasses may be host plants.

Of the genus *Trifolium*, red clover appears to be the most common choice as a food, while white clover (*T. repens*), crimson clover (*T. incarnatum*), and alsike clover (*T. hybridum*) are all fed upon to a greater or less extent by both the adults and larvae. Alfalfa (*Medicago sativa*) seems to be a common food plant for both larvae and adults. On June 17 the writer collected numerous larvae from among alfalfa roots in a field at Somerset Heights, Md., and while sweeping over a field of alfalfa with an insect net at Muirkirk, Md., on April 28, experienced no difficulty whatever in securing from six to eight adults with each sweep of the net. It seems likely that, with the increasing acreage of alfalfa, this insect may become a destructive pest and also menace this crop. The fact that alfalfa is always left standing on the same land for a fairly long period, from three to six years, may greatly accelerate the rapidity with which the insect will be able to increase in numbers.

#### NATURAL CHECKS.

The larva was found to be attacked by a fungus, one of the Entomophthoræ, which no doubt assists in keeping the insect in check. The larvae, because of their sluggish movements, might be easily captured and fed upon by predaceous beetles, but the fact that the larvae and pupæ are subterranean in their habits is a semiprotection from parasitic insects as well as from many predaceous enemies. No Hymenopterous or Dipterous parasites were observed.

#### BIRD ENEMIES.

The Biological Survey, in its work on the food habits of birds, has found that the following birds feed upon the adults of this beetle: Upland plover (*Bartramia longicauda*); killdeer or killdeer (*Oxyechus vociferus*); ruffed grouse (*Bonasa umbellus*); broad-winged hawk (*Buteo platypterus*); flicker (*Colaptes auratus*); night-hawk (*Chordeiles virginianus*); chimney swift (*Chaturga pelagica*); wood pewee (*Myiochanes viridicata*); crow blackbird (*Quiscalus quiscula*); meadowlark (*Sturnella magna*); Lincoln finch (*Melospiza lincolni*); song sparrow (*Melospiza melodia*); chipping sparrow (*Spizella passerina*); and the white-throated sparrow (*Zonotrichia albicollis*).

Of these birds the chimney swift and song sparrow were found to be the greatest feeders on the insect, as many as fifteen adult beetles being found in the stomach of one chimney swift, while but few less were found in stomachs of song sparrows.

## PREVENTIVES AND REMEDIES.

Up to the present time the depredations of this beetle have apparently been too limited and inconspicuous to call for investigations along the line of remedies and preventives.

The system of short crop rotation, so advantageously employed in the eastern United States, has no doubt assisted in limiting their number. Clover is, as a rule, grown for only a short period over the same piece of ground and thus no opportunity is afforded for the continuous development of the pest. On the other hand, the plan of allowing alfalfa to stand on the same ground for a period of from three to six years would probably facilitate the increase of the insect.

From the nature of the work of the beetles it is very hard to suggest any remedy that would destroy the beetle and not produce more or less damage to the clover crop. Clover fields might be burned over during the winter months, when the ground is frozen, without injuring the plants to any extent.

The fact that the larvae are easily killed when disturbed suggests a possible remedy in harrowing or cultivating the ground by some method in early spring and thus destroying a certain percentage of the larvae, but for this to be wholly effective a large amount of the clover would necessarily also be damaged and possibly killed.

As shown before, natural enemies, such as fungous diseases and birds, have without a doubt contributed largely toward holding the insects in check.

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